

valley, 86.2; Lower Missouri valley, 88.9; Northern Pacific coast region, 87.5; Central Pacific coast region, 86.6; Southern Pacific coast region, 88.3 per cent. There were 16 omissions to predict out of 3,813, or 0.42 per cent. Of the 3,797 predictions that have been made, 69, or 1.82 per cent, are considered to have entirely failed; 128, or 3.37 per cent, were one-fourth verified; 539, or 14.19 per cent, were one-half verified; 429, or 11.30 per cent, were three-fourths verified; 2,732, or 69.32 per cent, were fully verified, so far as can be ascertained from the tri-daily weather maps.

Cautionary Signals.—270 Cautionary Signals were displayed during the month, of which 223, or 82.5 per cent., were justified by winds of 25 miles per hour or over at, or within a radius of 100 miles of the station. 82 Off-shore Signals were displayed, of which 63, or 76.8 per cent, were fully justified; 72, or 87.8 per cent, were justified as to direction; 67, or 81.1 per cent, were justified as to velocity; and 6, or 7.3 per cent, were not justified either as to direction or velocity. 43 of the Off-shore were changed from Cautionary. 309 Signals of both kinds were displayed, of which 251, or 81.2 per cent, were fully justified. The above does not include signals ordered for 50 display stations, where the velocity is only estimated. 46 cases of winds of 25 miles and over per hour, from scattering stations, were reported, and for which signals had not been ordered. One signal was reported late.

NAVIGATION.

In the table on the right-hand side of chart No. III are given the highest and lowest readings of the Signal Service river-gauges for the month, with the dates of the same. The *Savannah*, at Augusta, changed but little previous to the 13th, then rose quite rapidly during the 15th, and reached its maximum of 30 feet on the 16th. During the remainder of the month it fell quite steadily. The *Red* continued nearly stationary during the first half of the month at a little less than 3 feet below the bench mark, (previous low water mark,) at Shreveport, then slowly rose, reaching the bench-mark night of the 18th, and its maximum height at the close of the month. In the *Arkansas*, at Little Rock, the oscillations have been slight and gradual, excepting a rise of nearly 5 feet on the 25th and 26th. The *Tennessee*, at Chattanooga, changed but little previous to 11th. During that day and the following it rose over 10 feet; on the 15th and 16th nearly 6 feet; 23rd to the 26 nearly 15 feet. At Nashville, the *Cumberland* rose over 8 feet from the 5th to 7th; fell over 5 feet to the 9th; rose over 17 feet by the 12th, and 7 more by the 16th; fell over 21 feet up to the 22nd; rose 22 feet by the 29th, when it reached its maximum. In the *Ohio* the changes were unimportant, excepting a slow increase of depth of water, until the 24th and 25th, when the river rapidly rose at Pittsburgh and Cincinnati; the 26th to 28th, from Louisville down. For the *Missouri* the changes are of little interest. At Yankton the river was frozen after the 2nd; at Omaha, after the 10th; at Leavenworth, after the 12th. In the *Mississippi*, above Cairo, the changes were slight and gradual. The river was frozen at St. Paul after the 7th; at La Crosse, after the 11th; at Dubuque, after the 16th; at Davenport, after the 18th; at Keokuk, after the 24th. At Cairo the river slowly rose to 30 feet by the 17th; fell to 25 feet on 23rd; then rose to its maximum at close of month. At Memphis it rose to 25 feet by the 20th; fell to less than 21 feet by 25th; then rose to nearly 27 feet on the 31st. At Vicksburg it steadily rose to over 30 feet by 25th, and remained nearly stationary thence to end of month. At New Orleans there was quite a steady and slow rise.

Ice in Rivers and Harbors.—The following notes on the formation of ice are of interest: The *Columbia river*.—At Umatilla, Or., closed to navigation on the 19th. The *Missouri*.—At Plattsburgh, Neb., ice gorged at rail-road pile bridge and froze solid on the 10th; 18 to 20 inches thick on the 31st. At Leavenworth, Kan., on the 11th and 12th, floating ice; 13th, ice gorged; 14th, river frozen over. At Kansas City, Mo., floating ice from 11th to 14th, river closed on 15th. Creswell, Kan., 12th, creeks frozen over. *Platte river*.—Closed with ice, and teams crossing on the 13th. The *Mississippi*.—At St. Paul, Minn., frozen over on the 8th. At LaCrosse, Wis., closed by ice on the 12th. At Dubuque, Ia., free of ice on the 5th; gorged on the 13th; frozen over on the 17th, passengers and teams crossing. At Davenport, Ia., floating ice on 1st, 11th, 12th, 15th to 18th; last boat of season passed down on the 14th; navigation closed on the 17th; frozen over on the 19th; vehicles crossing on ice 22nd. At Burlington, Ia., floating ice on the 1st, 2nd, 10th, 12th to 15th; navigation closed on the 10th; nearly frozen over on the 16th; frozen over on the 18th; people crossing on the ice on the 19th; teams crossing on the 20th. At Muscatine, Ia., frozen over on the 18th; teams crossing on 22nd. At Keokuk, Ia., floating ice from the 11th to the 25th, inclusive; river closed on the 25th; ice broken up on the 28th; navigation closed on the 11th. At St. Louis, Mo., floating ice on the 16th and 17th; 18th, navigation suspended; 21st, heavy; 22nd, 24th, 25th; 26th, gorged near bridge; 27th, 28th; gorged at St. Charles, 29th; river nearly clear on 30th. At Cairo, Ill., floating ice from 18th to 31st; very heavy from 26th to 31st, causing entire obstruction of navigation. *Des Moines river*.—At Des Moines, Ia., closed by ice on the 13th. At Boonesboro, Ia., closed by ice strong enough for teams to cross on the 10th. *Rock river*.—At Rockford, Ill., frozen over solid on the 12th; Lyndon, Ill., 12th, river closed with ice above the dam; 25th, closed with ice the below dam. *Skunk river*.—Ames Ia., river frozen over during the month. Tabor, Ia., 31st, ice in creeks fourteen inches thick. *Cottonwood river*.—Creswell, Kan., 26th, river and neighboring creeks frozen over. Wellington Kan., 31st, ice in creeks six inches thick. Cedar Vale, Kan., 12th to 31st, Caua creek frozen over. The *Ohio*.—At Cairo, Ill., drift wood in river from the 7th to the 17th, and from the 28th to the 31st. At Cincinnati, full of floating ice on the 27th. Miami canal closed by ice on the 26th. *Hudson river*.—At Garrison's, N. Y., navigation entirely suspended on the 31st. *Susquehanna*.—At Catawissa, Pa.,

closed by ice in several places on the 31st; navigation closed on north branch of Pennsylvania canal on the 17th; on the west branch on the 12th; canal frozen over on the 18th. *Connecticut*.—Springfield, Mass., 22nd, river closed with ice; 29th, river in many places clear of ice; Fall River, Mass., 22nd, North Watuppa Lake, frozen for first time this season. *St. Lawrence river*.—frozen over at Montreal on the 29th. *Newburyport, Mass.*—river and harbor entirely free from ice on 31st. *Lakes*.—Marquette, Mich., harbor frozen over from 18th to 21st. Grand Haven, Mich., harbor frozen over from 16th to 31st. Duluth, Minn., harbor frozen from 12th to 31st. Escanaba, Mich., ice in bay entire month. Port Huron, Mich., navigation closed on the 14th; Ft. Gratiot light extinguished for the season on the 19th. Alpena, Mich., last steamer of season left for Detroit on the 7th; bay full of ice on 12th. Chicago, Ill., lake frozen along the shore on the 15th; navigation closed on the 16th; all vessels laid up on the 17th. Buffalo, N. Y., canal navigation closed on the 6th, lake navigation on the 27th; Buffalo Creek and river frozen over on 26th. Oswego, N. Y., navigation closed on the 1st; all vessels laid up for the winter on the 11th. Detroit, Mich., floating ice in river on the 16th; ice along shore on the 26th. Cleveland, Ohio, navigation closed on the 9th; ice forming along the wharves on the 16th; river frozen over, 18th; floating ice in lake in large quantities on the 26th. Toledo, Ohio, navigation practically closed on the 4th; river partly covered by ice, 13th; frozen over, 16th; navigation closed, 17th. Erie, Pa., harbor lights discontinued for the season. *Lake Champlain*.—Burlington, Vt., ice broken up in river on the 15th; on the 15th at Rouse's Point, Can., 45 vessels fast in the ice, and between Rouse's Point and Sorel 100 vessels ice-bound; lake frozen over from Crown Point to Whitehall; people and teams crossing on ice between Ticonderoga and Bridgeport on the 26th; ice bridge between St. Alban's, Vt., and the islands in the lake firm on the 29th, and 6 inches thick in the thinnest part.

High Tides.—Cape Lookout, N. C., 13th; Macon, N. C., 13th, 14th, 15th, 16th; Atlantic City, N. J., 15th, very high tides, trains delayed in crossing the meadows.

Low Tides.—Indianola, 26th, 27th, 28th, 29th, 30th, 31st.

TEMPERATURE OF WATER.

The *temperatures of water*, as observed in rivers and harbors, with average depth at which observations were taken, are given in table on left side of chart No. II. At the following stations observations were not made on the dates indicated: on account of ice, at Alpena, from 21st to 31st, inclusive; Buffalo, 26th to 31st; Chicago, 15th to 31st; Detroit, 16th to 23rd and 26th to 31st; Duluth, 13th to 31st; Escanaba, 1st to 31st; Grand Haven, 16th to 31st; Marquette, 18th to 21st; Milwaukee, on the 21st and 23rd; Toledo, 16th to 31st. At Cleveland the lake was too rough for observations to be taken on the 7th, 10th, 11th, 15th and 22nd. At Savannah, 15th to 21st; at Punta Rassa, 6th to 31st, and Augusta, 14th to 25th, observations were interrupted by loss or breakage of thermometer.

ATMOSPHERIC ELECTRICITY.

Thunder-storms were reported in the various states on the following dates:—Pennsylvania, 11th; New Jersey, 6th; Maryland, 6th, Virginia, 6th, 26th; North Carolina, 6th; Georgia, 11th, 15th; Florida, 5th, 11th, 15th; Alabama, 5th; Mississippi and Louisiana, 5th, 10th; Texas, 4th, 5th, 9th, 10th, 13th, 23rd, 24th, 31st; Arkansas, 3rd, 9th, 24th; Indian Territory, 4th; Tennessee, 6th, 22nd, 23rd; Ohio, 9th, 21st, 22nd; Indiana, 3rd, 9th, 21st, 22nd; Michigan, 9th, 10th; Wisconsin, 9th; Iowa, 9th; Illinois, 9th, 10th, 21st; Missouri, 4th, 5th, 9th, 21st; Kansas, 4th, 5th, 9th, 30th.

Auroras.—Cornish, Me., 7th, 8th. Fall River, Mass., 12th. Thornville, Mich., 10th, 9 p. m., dimly defined arch with streamers. Argyle, N. Y., 17th, 9 p. m., diffuse light. Cambridge, Mass., regularly looked for at 8 p. m.; suspected, 7th, 9th; decidedly cloudy, 2nd, 3rd, 5th, 6th, 8th, 10th, 11th, 13th, 14th, 16th, 19th, 20th, 24th; some clouds or haze, 4th, 15th; some clouds and moonlight, 1st, 17th, 21st; moonlight, 18th, 26th, 27th; no record, 22nd, 23rd, 25th, 28th, 29th, 30th, 31st; aurora, if present, would have been seen on the 12th. Burlington, Vt., 7th, 11 p. m., an arch of light, of a pale green, with a few streamers above a well defined dark segment; 8th, 9 p. m., diffuse light. Wellsboro, Pa., 12th, 8.20 to 10.30 p. m.; 18th, 9 p. m. to midnight. Newport and Woodstock, Vt., 8th. Manitowoc, Wis., 7th, 11th.

Telegraphic communication interfered with by atmospheric electricity.—Bismarck, 10th, 22nd, 23rd; Coleman and Mason, Tex., 4th; Indianola, 5th, 12th, 18th.

OPTICAL PHENOMENA.

Solar Halos were observed in the various districts on the following dates: New England, 18th to 21st, 23rd to 25th, 28th to 31st. Middle Atlantic States, 1st to 3rd, 16th, 18th, 20th to 25th, 27th to 31st. South Atlantic States, 3rd, 4th, 8th, 11th, 19th to 22nd, 24th, 27th, 29th, 30th, 31st. Eastern Gulf States, 1st, 18th, 19th, 21st, 23rd, 27th, 28th. Western Gulf States, 1st, 2nd, 3rd, 18th to 23rd, 27th. Lower Lake region, 1st, 3rd, 18th, 23rd, 25th, 27th. Upper Lake region, 1st, 2nd, 20th, 24th, 25th, 27th, 28th, 31st. Ohio valley and Tennessee, 1st, 2nd, 19th, 24th to 28th, 30th. Upper Mississippi valley, 1st, 2nd, 6th, 10th, 11th, 15th, 17th, 20th, 24th, 26th to 30th. Missouri valley, 1st, 2nd, 3rd, 4th, 17th, 18th, 19th, 20th to 24th, 27th to 31st. Rocky Mountains, 2nd, 18th, 23rd, 26th, 27th, 28th. Western Plateau, 1st, 21st, 23rd, 26th, 28th, 30th. California, 5th, 23rd. Washington Territory, 4th.

Lunar Halos were observed in the various districts on the following dates: New England, 1st, 2nd, 3rd, 13th, 19th, 23rd to 25th, 27th, 30th; Middle Atlantic States, 3rd, 13th, 26th, 27th; South Atlantic